IN THE CLAIMS

All pending claims are reproduced below:

1. (Currently Amended) A computer readable storage medium encoded with computer executable instructions for controlling a processor to perform a computer implemented method of determining a motion vector for encoding a block of a predicted video frame with respect to a reference video frame, the method comprising:

establishing a size for phase correlation blocks, the size of the phase correlation blocks being larger than the maximum allowable magnitude of the motion vector;

within an inner area of the phase correlation block of the predicted video frame, the inner area having a size equal to or less than the maximum allowable magnitude of a motion vector, identifying a number of highest phase correlation peaks between a phase correlation block of the predicted video frame and a corresponding phase correlation block of the reference video frame,;

determining for each phase correlation peak identified in the inner area, a motion vector; and

selecting from the determined motion vectors, a motion vector that ~~minimizes a~~ has the minimum distortion measure between the block and a reference block offset from the block by the motion vector among the determined motion vectors.

2. (Previously Presented) The computer implemented method of claim 1, wherein identifying at least one highest phase correlation peak between a phase correlation block of the predicted video frame and a corresponding phase correlation block of the reference video frame, comprises:

applying a Fourier transform to a phase correlation block of predicted video frame and a corresponding phase correlation block of the reference video frame;

determining a normalized cross product of the Fourier transforms;

determining an inverse Fourier transform to obtain a phase correlation surface; and

determining at least one peak on phase correlation surface.

3. (Currently Amended) The computer implemented method of claim 1, wherein identifying at least one highest phase correlation peak, comprises:

determining for each peak a motion vector;

selecting from the determined motion vectors, a motion vector that ~~minimizes a~~ has the minimum distortion measure between the block and a block of the reference video frame offset from the block by the motion vector among the determined motion vectors.

4. (Currently Amended) The computer implemented method of claim 1, wherein selecting a motion vector, comprises:

applying each of the motion vectors to the block to obtain the reference block in the reference video frame;

selecting the motion vector that ~~minimizes a~~ has the minimum distortion measure between the block and the reference block among the determined motion vectors.

5. (Original) The computer implemented method of claim 1, wherein each phase correlation block has horizontal and vertical dimensions that are a function of a maximum magnitude of the motion vectors.

6. (Previously Presented) The computer implemented method of claim 5, wherein the horizontal and vertical dimensions M and N, are each a power of 2 greater than 2S+16, where S is the maximum magnitude of the motion vectors in horizontal and vertical direction, respectively.

7. (Previously Presented) The computer implemented method of claim 1, further comprising:

applying to the phase correlation block of the predicted video frame a windowing function prior to determining the at least one phase correlation peak.

8. (Original) The computer implemented method of claim 7, wherein the windowing function reduces discontinuity between adjacent phase correlation blocks.

9. (Original) The computer implemented method of claim 7, wherein the windowing function is a smoothing function at the edges of the phase correlation block.

10. (Original) The computer implemented method of claim 7, wherein the windowing function is an extended 2D cosine bell function.

11. (Original) The computer implemented method of claim 10, wherein the windowing function is:

$$W(m,n) = \begin{cases} \frac{1}{2}\left[1-\cos\left(\frac{16*m*\Pi}{M}\right)\right]*\frac{1}{2}\left[1-\cos\left(\frac{16*n*\Pi}{N}\right)\right] \ldots for\left(\frac{M}{16} \leq m \ldots or \ldots m \geq \frac{15*M}{16}\right) and \left(\frac{N}{16} \leq n \ldots or \ldots n \geq \frac{15*N}{16}\right) \\ 1 \ldots otherwise \end{cases}$$

where M is a width of a phase correlation block and N is a height of a phase correlation block.

12. (Previously Presented) The computer implemented method of claim 1, wherein phase correlation blocks of the predicted video frame are non-overlapping.

13. (Previously Presented) The computer implemented method of claim 1, wherein phase correlation blocks of the predicted video frame are overlapping.

14. (Original) The computer implemented method of claim 13, wherein the phase correlation blocks overlap by a minimum overlap value, where the minimum overlap value is greater than or equal to a maximum magnitude of the motion vectors.

15. (Original) The computer implemented method of claim 13, wherein selecting from the motion vectors comprises selecting from the motion vectors associated with all phase correlation blocks that include the block.

16. (Previously Presented) The computer implemented method of claim 1, wherein identifying a number of highest phase correlation peaks comprises:

determining a fixed number of correlation peaks.

17. (Canceled)

18. (Canceled)

19. (Canceled)

20. (Previously Presented) The computer implemented method of claim 1, wherein identifying at least one highest phase correlation peak comprises interpolating subpixel peak values from the phase correlation peaks at pixel locations in the phase correlation block.

21. (Canceled)

22. (Original) The computer implemented method of claim 1, wherein selecting a motion vector comprises:

selecting a first motion vector which reduces the distortion measure below a threshold value.

23. (Original) The computer implemented method of claim 22, wherein the threshold is a fixed distortion threshold.

24. (Original) The computer implemented method of claim 22, wherein the threshold is an adaptive distortion threshold.

25. (Original) The computer implemented method of claim 24, wherein the adaptive distortion threshold is a minimum distortion measure of a plurality of neighboring blocks.

26. (Previously Presented) A method of determining motion vectors for encoding a predicted video frame with respect to a reference video frame, the method comprising:

determining a phase correlation between the predicted video frame and the reference video frame, wherein the phase correlation produces a phase correlation surface including a number of highest phase correlation peaks, the number of phase correlation peaks determined as a function of a size of the block to be predicted; and

determining the motion vectors for encoding the predicted video frame from motion vectors defined by locations of the phase correlation peaks on the phase correlation surface.

27. (Currently Amended) A computer readable storage medium encoded with computer executable instructions for controlling a processor to perform a computer implemented method of determining motion vectors for encoding blocks of video frames, the video frames including a predicted frame with respect to a reference frame, the method comprising:

establishing a size for phase correlation blocks, and the size for the phase correlation blocks being larger than the maximum allowable magnitude of the motion vector;

dividing the predicted frame and the reference frame into a plurality of phase correlation blocks, each phase correlation block including a number of blocks;

for each phase correlation block in the predicted frame, within an inner area of the phase correlation block of the predicted frame, the inner area having a size equal to or less than the maximum allowable magnitude of a motion vector, identifying a number of highest phase correlation peaks between the phase correlation block and a corresponding phase correlation block of the reference frame, and for each phase correlation peak identified in the inner area, determining an associated motion vector; and

for each phase correlation block in the predicted frame, and for each block to be predicted in the phase correlation block, selecting from the determined motion vectors associated with the phase correlation block, a motion vector that ~~minimizes a~~ has the minimum distortion measure between the block and a reference block in the reference frame offset from the block by the motion vector among the determined motion vectors.

28. (Currently Amended) An apparatus for determining a motion vector for encoding video frames, the video frames including a predicted frame and a reference frame, the apparatus comprising:

a motion estimator circuit adapted to identify, within an inner area of a phase

correlation block of the predicted frame, the inner area having a size equal to or less than maximum allowable magnitude of a motion vector, a number of highest phase correlation peaks between the phase correlation block of the predicted frame and a corresponding phase correlation block of the reference frame, the size of the phase correlation block being larger than the maximum allowable magnitude of the motion vector, determine a motion vector for each phase correlation peak identified in the inner area, and select from the determined motion vectors, a motion vector that ~~minimizes a~~ has the minimum distortion measure between the block and a reference block offset from the block by the motion vector among the determined motion vectors.

29. (Original) The apparatus of claim 28, wherein the motion estimator circuit is further adapted to apply a Fourier transform to a phase correlation block of predicted frame and a corresponding phase correlation block of the reference frame, determine a normalized cross product of the Fourier transforms, and apply an inverse Fourier transform circuit to obtain the phase correlation surface.

30. (Currently Amended) The apparatus of claim 28, wherein the motion estimator circuit is further adapted to determine for each peak a motion vector, and select from the determined motion vectors, a motion vector that ~~minimizes a~~ has the minimum distortion measure between the block and a block of the reference frame offset from the block by the motion vector among the determined motion vectors.

31. (Currently Amended) The apparatus of claim 28, wherein the motion estimator circuit is further adapted to apply each of the motion vectors to the block to obtain the reference block in the reference frame, and select the motion vector that ~~minimizes a~~ has the minimum distortion measure between the block and the reference block among the determined motion vectors.

32. (Original) The apparatus of claim 28, wherein each phase correlation block has horizontal and vertical dimensions that are a function of a maximum magnitude of the motion.

33. (Previously Presented) The apparatus of claim 32, wherein the horizontal and vertical dimensions M and N, are each a power of 2 greater than 2S+16, where S is the maximum magnitude of the motion vectors in horizontal and vertical direction, respectively.

34. (Original) The apparatus of claim 28, wherein the motion estimator circuit is further adapted to apply to the phase correlation block of the predicted frame a windowing function prior to determining the phase correlation peaks.

35. (Original) The apparatus of claim 34, wherein the windowing function reduces discontinuity between adjacent phase correlation blocks.

36. (Original) The apparatus of claim 34, wherein the windowing function is a smoothing function at the edges of the phase correlation block.

37. (Original) The apparatus of claim 34, wherein the windowing function is an extended 2D cosine bell function.

38. (Original) The apparatus of claim 34, wherein the windowing function is:

$$W(m,n)=\begin{Bmatrix} \frac{1}{2}\left[1-\cos\left(\frac{16*m*\Pi}{M}\right)\right]*\frac{1}{2}\left[1-\cos\left(\frac{16*n*\Pi}{N}\right)\right]\ldots for\left(\frac{M}{16}\le m\ldots or\ldots m\ge\frac{15*M}{16}\right)and\left(\frac{N}{16}\le n\ldots or\ldots n\ge\frac{15*N}{16}\right) \\ 1\ldots otherwise \end{Bmatrix}$$

where M is a width of a phase correlation block and N is a height of a phase correlation block.

39. (Original) The apparatus of claim 28, wherein phase correlation blocks of the predicted frame are non-overlapping.

40. (Original) The apparatus of claim 28, wherein phase correlation blocks of the predicted frame are overlapping.

41. (Original) The apparatus of claim 28, wherein the phase correlation blocks overlap by a minimum overlap value, where the minimum overlap value is greater than or equal to a maximum magnitude of the motion vectors.

42. (Original) The apparatus of claim 28, wherein the motion estimator circuit is further adapted to select a motion vector from the motion vectors associated with all phase correlation blocks that include the block.

43. (Original) The apparatus of claim 28, wherein the motion estimator circuit is further adapted to determine a fixed number of correlation peaks.

44. (Original) The apparatus of claim 28, wherein the motion estimator circuit is further adapted to determine a variable number of correlation peaks.

45. (Original) The apparatus of claim 28, wherein the motion estimator circuit is further adapted to determine a number of correlation peaks as a function of a size of the block.

46. (Original) The apparatus of claim 28, wherein the motion estimator circuit is further adapted to determine a number of correlation peaks as a function of a variance of the values of the phase correlation peaks.

47. (Original) The apparatus of claim 28, wherein the motion estimator circuit is further adapted to interpolate subpixel peak values from the phase correlation peaks at pixel locations in the phase correlation block.

48. (Original) The apparatus of claim 28, wherein the motion estimator circuit is further adapted to determine a plurality of subpixel motion vectors near the selected motion vector, and select one of the plurality of subpixel motion vectors.

49. (Original) The apparatus of claim 28, wherein the motion estimator circuit is further adapted to select a first motion vector which reduces the distortion measure below a threshold value.

50. (Original) The apparatus of claim 49, wherein the threshold is a fixed distortion threshold.

51. (Original) The apparatus of claim 49, wherein the threshold is an adaptive

distortion threshold.

52. (Original) The apparatus of claim 51, wherein the adaptive distortion threshold is a minimum distortion measure of a plurality of neighboring blocks.

53. (Currently Amended) An apparatus for determining a motion vector for encoding ~~a~~ video frames, the video frames including a predicted frame and a reference frame, the apparatus comprising:

circuit means for identifying, within an inner area of a phase correlation block of the predicted frame, the inner area having a size equal to or less than maximum allowable magnitude of a motion vector, a number of highest phase correlation peaks between the phase correlation block of the predicted frame and a corresponding phase correlation block of the reference frame, the size of the phase correlation block being larger than the maximum allowable magnitude of the motion vector, determining a motion vector for each phase correlation peak identified in the inner area, and selecting from the determined motion vectors, a motion vector that ~~minimizes a~~ has the minimum distortion measure between the block and a reference block offset from the block by the motion vector among the determined motion vectors.

54. (Canceled).

55. (Canceled)

56. (Canceled)

57. (Currently Amended) A computer readable storage medium encoded with computer executable instructions for controlling a processor to perform a computer implemented method of determining a motion vector for encoding a block of a predicted video frame with respect to a reference video frame, the method comprising:

within an inner area of a phase correlation block of the predicted video frame, the inner area having a size equal to or less than maximum allowable magnitude of

a motion vector, identifying a number of highest phase correlation peaks between the phase correlation block of the predicted video frame and a corresponding phase correlation block of the reference video frame, the size of the phase correlation block being larger than the maximum allowable magnitude of the motion vector;

determining for each phase correlation peak identified in the inner area, a motion vector; and

selecting from the determined motion vectors, a motion vector that ~~minimizes a~~ has the minimum distortion measure between the block and a reference block offset from the block by the motion vector among the determined motion vectors.

58. (Currently Amended) A computer readable storage medium encoded with computer executable instructions for controlling a processor to perform a computer implemented method of determining a motion vector for encoding a block of a predicted video frame with respect to a reference video frame, the method comprising:

within an inner area of a phase correlation block of the predicted video frame, the inner area having a size equal to or less than maximum allowable magnitude of a motion vector, identifying a number of highest phase correlation peaks between the phase correlation block of the predicted video frame and a corresponding phase correlation block of the reference video frame, the size of the phase correlation block being larger than the maximum allowable magnitude of the motion vector;

determining for each phase correlation peak identified in the inner area, a motion vector;

determining for each motion vector, a plurality of subpixel motion vectors near the motion vector; and

for each motion vector, selecting one of the plurality of subpixel motion vectors that ~~minimizes a~~ has the minimum distortion measure between the block and a reference block offset from the block by the motion vector among the determined plurality of subpixel motion vectors.

59. (Currently Amended) A computer readable storage medium encoded with computer executable instructions for controlling a processor to perform a computer implemented method of determining a motion vector for encoding a block of a predicted video frame with respect to a reference video frame, the method comprising:

determining maximum allowable dimensions of a motion vector for encoding a block;

establishing a phase correlation block having dimensions being larger than the maximum allowable dimensions of the motion vector;

determining a search area within the phase correlation block, the search area having dimensions smaller than the dimensions of the phase correlation block;

identifying a plurality of phase correlation peaks between a phase correlation block of the predicted video frame and a corresponding phase correlation block of the reference video frame, the phase correlation block of the predicted video frame including the block;

determining a respective motion vector for each identified peak correlation peaks within the search area of the phase correlation block; and

selecting from the determined motion vectors, a motion vector that ~~minimizes a~~ has the minimum distortion measure between the block and a reference block offset from the block by the motion vector among the determined motion vectors.

60. (Currently Amended) A computer readable storage medium encoded with computer executable instructions for controlling a processor to perform a computer implemented method of determining a motion vector for encoding a block of a predicted video frame with respect to a reference video frame, the method comprising:

determining maximum allowable dimensions of a motion vector for encoding a block;

establishing a phase correlation block having dimensions being larger than the maximum allowable dimensions of the motion vector;

determining a search area within the phase correlation block, the search area having dimensions smaller than the dimensions of the phase correlation block;

identifying a plurality of phase correlation peaks between a phase correlation block of the predicted video frame and a corresponding phase correlation block of the reference video frame, the phase correlation block of the predicted

video frame including the block;

discarding those identified peak correlation peaks outside of the search area of the phase correlation block; and

determining a respective motion vector for each of the remaining identified peak correlation peaks; and

selecting from the determined motion vectors, a motion vector that ~~minimizes a~~ has the minimum distortion measure between the block and a reference block offset from the block by the motion vector among the determined motion vectors.

61. (Currently Amended) A computer readable storage medium encoded with computer executable instructions for controlling a processor to perform a computer implemented method of determining a motion vector for encoding a block of a predicted video frame with respect to a reference video frame, the method comprising:

establishing an inner area within a phase correlation block, the inner area smaller than the phase correlation block;

identifying within the inner area a number of highest phase correlation peaks between a phase correlation block of the predicted video frame and a corresponding phase correlation block of the reference video frame, the phase correlation block of the predicted video frame including the block;

determining a respective motion vector for each of the identified peak correlation peaks; and

selecting from the determined motion vectors, a motion vector that ~~minimizes a~~ has the minimum distortion measure between the block and a reference block offset from the block by the motion vector among the determined motion vectors.

62. (Previously Presented) The computer implemented method of claim 1, wherein the maximum allowable magnitude of the motion vector is based on an encoding parameter for controlling image quality.

63. (Previously Presented) The computer implemented method of claim 1, wherein the number of the identified phase correlation peaks increases as the size of the phase correlation block increases.

64. (Previously Presented) The computer implemented method of claim 1, wherein the inner area of the phase correlation block is centrally positioned within the phase correlation block.

65. (Previously Presented) The computer implemented method of claim 27, wherein the maximum allowable magnitude of the motion vector is based on an encoding parameter for controlling image quality.

66. (Previously Presented) The computer implemented method of claim 27, wherein the number of the identified phase correlation peaks increases as the size of the phase correlation block increases.

67. (Previously Presented) The computer implemented method of claim 27, wherein the inner area of the phase correlation block is centrally positioned within the phase correlation block.

68. (Previously Presented) The apparatus of claim 28, wherein the maximum allowable magnitude of the motion vector is based on an encoding parameter for controlling image quality.

69. (Previously Presented) The apparatus of claim 28, wherein the number of the identified phase correlation peaks increases as the size of the phase correlation block increases.

70. (Previously Presented) The apparatus of claim 28, wherein the inner area of the phase correlation block is centrally positioned within the phase correlation block.

71. (Previously Presented) The apparatus of claim 53, wherein the maximum allowable magnitude of the motion vector is based on an encoding parameter for controlling image quality.

72. (Previously Presented) The apparatus of claim 53, wherein the number of the identified phase correlation peaks increases as the size of the phase correlation block increases.

73. (Previously Presented) The apparatus of claim 53, wherein the inner area of the phase correlation block is centrally positioned within the phase correlation block.

74. (Previously Presented) The computer implemented method of claim 57, wherein the maximum allowable magnitude of the motion vector is based on an encoding parameter for controlling image quality.

75. (Previously Presented) The computer implemented method of claim 57, wherein the number of the identified phase correlation peaks increases as the size of the phase correlation block increases.

76. (Previously Presented) The computer implemented method of claim 57, wherein the inner area of the phase correlation block is centrally positioned within the phase correlation block.

77. (Previously Presented) The computer implemented method of claim 58, wherein the maximum allowable magnitude of the motion vector is based on an encoding parameter for controlling image quality.

78. (Previously Presented) The computer implemented method of claim 58, wherein the number of the identified phase correlation peaks increases as the size of the phase correlation block increases.

79. (Previously Presented) The computer implemented method of claim 58, wherein the inner area of the phase correlation block is centrally positioned within the phase correlation block.